Appendix B

OLIGOHALINE ZONE LITERATURE REVIEW REPORT

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INTRODUCTION

The oligohaline, or low-salinity, region of an estuary occurs where fresh and saline waters meet. The oligohaline salinity range is typically defined as 0.5 to 5.0 ppt (Day et al. 1989), although some studies extend the range to 10 ppt (Coastal Environmental 1992, Peterson 1991, Holmes et al. 2000). In contrast to the higher salinity portions of estuaries, relatively few studies have focused on the oligohaline zone (Hackney and de la Cruz 1981, Hastings et al. 1987, Rozas and Odum 1987, Odum 1988, LaSalle and Bishop 1990, Wagner and Austin 1999, Holmes et al. 2000, Hughes et al. 2000). There are no known studies detailing the functions of the oligohaline zone(s) of the St. Lucie Estuary; however, several studies have identified fish species which occur in low salinity portions of the estuary (Gunter and Hall 1963; Haunert and Startzman 1980, 1985).

The purpose of this report is to summarize available literature regarding the importance of oligohaline zones in estuaries to assist with development of minimum flows and levels criteria for the St. Lucie Estuary. The studies reviewed generally characterize the oligohaline zone as a physically demanding, dynamic, and highly productive area. These studies suggest processes that occur in this zone are important to overall estuarine ecosystem health. This report summarizes: 1) some important physical, chemical, and biological processes that occur in the oligohaline zone; 2) the role of the oligohaline zone as a buffer to downstream waters; and 3) the habitat/nursery value of the oligohaline zone.

PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES

Freshwater inflow to estuaries determines the size and position of the oligohaline zone. Because estuarine inflows are typically variable, the size and position of the oligohaline are variable. The physically dynamic nature of the oligohaline zone, dramatic ionic changes that occur at very low salinities (probably between 1 and 2 ppt; Deaton and Greenberg 1986), and high turbidity often associated with this region (Sin et al 1999) make it a difficult place for organisms to live. Few species have adapted to low-salinity environments (Boesch 1971, Remane and Schlieper 1971). However, those species able to survive these harsh conditions have the advantage of reduced competition, few predators/disease, and abundant food supply (Rozas and Hackney 1983; Browder 1991). These factors may be what attracts some organisms to the oligohaline zone, rather than a specific salinity range (Rozas and Hackney 1984; Livingston 1997).

The abundant food supply associated with oligohaline zones is largely due to the nutrients associated with freshwater inflow. These nutrients support phytoplankton growth that can form

the base of an extensive estuarine food chain (Hughes et al. 2000). In order for the nutrients to be available for phytoplankton growth within the oligohaline zone, appropriate freshwater discharge rates are needed. Since freshwater discharge rates affect residence time, nutrient input, light regime, and tidal mixing, they can regulate the magnitude, location and timing of primary production in an estuary (Sin et al 1999). If discharge is too high the nutrients and/or phytoplankton may be flushed downstream (Holmes et al 2000) and organisms that depend on this food source may have to leave the "refuge" (few predators, less competition) of the oligohaline zone to take advantage of the food supply. This could affect community structure throughout the estuary and its receiving waters.

Additionally, important transformations of nutrients occur in the upper estuary (Alpine and Cloern 1992; Holmes et al 2000). The processing of nutrients in the oligohaline zone is an important function that can influence energy transported throughout the estuary. Holmes et al (2000) and Hughes et al (2000) found that all watershed-derived dissolved inorganic nitrogen was rapidly processed in the oligohaline zone during low flow conditions in the Parker River Estuary in Massachusetts. They indicated that this highlights the importance of the oligohaline zone to the nitrogen cycle of the entire estuary.

Anderson (1986), studying three sub-estuaries of the Chesapeake Bay, found that freshwater diatoms depleted dissolved reactive silica (DSi), a critical nutrient for diatom growth, in the water column before the freshwater flow reached the oligohaline zone. Despite this depletion, he found that DSi levels increased in the oligohaline zone. He suggested that this increase may be a result of the lysing of diatom cells in response to the rapid salinity change in the oligohaline zone. Anderson suggests that this process accelerates remineralization of silica (and probably nitrogen and phosphorus) into the estuary and points to the importance of the oligohaline zone in the cycling of silica.

BUFFER

The processing of nutrients, discussed above, as well as, other chemical, physical, and biological transformations in the oligohaline zone (Morris et al. 1978) affect the material and energy transported downstream to the estuary and ultimately the ocean. Holmes et al (2000) therefore suggest that the oligohaline zone can be considered an important "buffer or ecotone" between the watershed and lower estuary and ocean. Odum et al 1984, suggested that because of its intermediate position between coastal waters and freshwaters, pollutants (heavy metals, nutrients, suspended solids, etc.) from upstream may be partially intercepted and processed in low salinity areas. In this regard, the oligohaline zone may act as a filter effectively improving the health of downstream habitats.

HABITAT VALUE

Most of the studies reviewed focused on the habitat value of the oligohaline zone. It is apparent that low salinity waters in the upper estuary are critical to the life histories of many estuarine organisms (Holmes et al 2000; Hughes et al 2000). A summary of the habitat and/or nursery functions of the oligohaline zone for a wide variety of organisms is presented below.

Microinvertebrates

As discussed above, the freshwater inflow brings with it nutrients which are used by phytoplankton. The phytoplankton then becomes food for zooplankton such as copepods. In an oligohaline study conducted by Hughes et al (2000), the most important oligohaline planktonic primary consumer was the copepod, *Eurytemora affinis*, which is found ubiquitously in low salinity waters of North America. This particular copepod appears to mature in the oligohaline zone; consuming diatoms and detritus. Holmes et al (2000) suspect that a similar trophic structure occurs in the oligohaline zone of other estuaries that support phytoplankton blooms.

Macroinvertebrates

The oligohaline zone provides habitat for numerous macroinvertebrates. Boesch and Diaz (1974) found that peracarids (amphipods, isopods, etc.) were more diverse than most other invertebrate groups in oligohaline environments and were probably ecologically important in this zone. Dauvin (2000) reported decapods and peracarids dominate the water column near the bottom of the English Channel forming a direct link between the benthos and the pelagos because of daily vertical and horizontal migrations. In the Seine estuary, Dauvin (2000) found that biomass of suprabenthic hauls were very high, especially in the mesohaline and oligohaline zones where mysids were abundant.

Other studies focused on the use of the oligohaline zone by barnacles and molluscs. Poirrier and Partridge (1979) studied an oligohaline barnacle, *Balanus subalbidus*, which is reported from estuaries on the East Coast of the United States (including Florida). It is an apparent indicator species of low-salinity environments because densities of this organism quickly drop off at salinities above 6 ppt. Another study pointed to the abundance of gastropods and bivalves in poorly flooded oligohaline marshes (Bishop and Hackney 1987). One specific bivalve, *Rangia cuneata*, grew to greatest size in very low salinity habitats (Gunter 1961).

Larval Insects

Oligohaline marshes support abundant populations of larval insects, particularly dipteran species (Menzie 1980; LaSalle and Bishop 1987, 1990). LaSalle and Bishop (1987, 1990) suggest that low salinity marsh habitats support a larger number of larval insect species than higher salinity areas. Diptera in oligohaline marshes consume oligochaetes, nematodes, and polychaetes, which primarily feed on the microbial-detritus complex (LaSalle and Bishop 1987, 1990). The larval insects are in turn consumed by aquatic predators such as fish. Additionally, when the insects emerge from their aquatic habitat as adults, they provide an important pathway of energy (biomass) flow into terrestrial ecosystems. Larval insect fauna in oligohaline zones may contribute importantly to the trophic dynamics of estuarine systems (Menzie 1980).

Fisheries

Most of the habitat studies reviewed focused on the use of the oligohaline zone by fish. Many of the species of fish inhabiting the oligohaline zone support economically important commercial

and sport fisheries (Rozas and Hackney 1983, Day et al. 1989, Edwards 1992). **Table B-1** provides a list of fish species identified through this literature review that use the oligohaline zone for some part of their life history. The oligohaline zone supports freshwater, estuarine, and marine fishes (Rozas and Hackney 1983, Odum et al. 1988, Peterson and Ross 1991); however, marine and estuarine species numerically dominate the oligohaline fauna (Gunter 1956).

Although the vast majority of fish found in the oligohaline zone are juveniles, several studies pointed to the use of the oligohaline zone by adult fish for spawning and feeding. Striped bass (*Morone saxatilis*), an important commercial and sport fish, is known to spawn and feed in oligohaline and fresh waters (Rozas and Hackney 1983, Odum et al. 1984). Freshwater species observed spawning in oligohaline waters include bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides;* Rozas and Hackney 1983). Only a few fish are known to be true residents of the oligohaline zone (mosquito fish, *Gambusia affinis*, tidewater silversides, *Menidia beryllina*, and grass shrimp, *Palaemonetes pugio;* Rozas and Hackney 1984). In addition to finfish, blue crabs (*Calinectes sapidus*), especially adult males, are known to feed in oligohaline waters (Rozas and Hackney 1983).

The vast majority of the oligohaline fisheries literature focused on the use of this zone as a nursery (Gunter 1961, Weinstein 1979, Day et al. 1980, Rozas and Hackney 1983, Rogers et al. 1984, Rozas and Hackney 1984, Deegan and Thompson 1985, Ross and Epperly 1985, Felley 1987, Browder 1991, Peterson and Ross 1991, Coastal Environmental 1992, Deegan and Garritt 1997, Wagner and Austin 1999). In general, smaller and younger fish initially distribute themselves in lower salinity water and migrate towards sea as they grow larger (Gunter 1961). At least some juvenile fish have lengthy stays in the oligohaline zone. Deegan and Garritt (1997) found that some fish stay in the oligohaline zone from spring through the summer. Weinstien (1979) found that some species remain in the oligohaline zone from winter through fall. For at least one species, the Atlantic menhaden (*Brevoortia tyranus*), the oligohaline zone may be essential for development into juveniles (Rozas and Hackney 1984).

DISCUSSION

Although studies of the oligohaline zone of estuaries are limited, it is clear that the oligohaline zone is an important estuarine region and that maximizing this zone in an estuary will benefit the estuarine ecology. Physical, chemical, and biological processes in the oligohaline zone are important to estuarine primary productivity and provide a unique habitat and refuge for numerous organisms. The oligohaline zone also acts as a buffer, ecotone, and filter between tidal freshwater areas and downstream estuarine habitats. Additionally, the oligohaline zone provides habitat, including nursery areas, for numerous freshwater, estuarine, and marine organisms.

Although studies specific to the St. Lucie Estuary oligohaline zone(s) have not yet been conducted, it is reasonable to expect that the functions described above for other estuaries would be provided in the oligohaline reaches of this estuary. For example, numerous fish species found in the St. Lucie Estuary (**Table B-1**) are known to occur in oligohaline regions. Restoration and maintenance of a healthy, productive oligohaline zone would benefit these fish species as well as

numerous other organisms. Ultimately this should improve sport and commercial fisheries in the area.

Through the minimum flows and levels criteria development process for the St. Lucie Estuary, decisions will be needed on appropriate size and location of the oligohaline zone. The location and size of this zone will be dictated by freshwater inflow. Optimizing the oligohaline zone will require maximizing the overlap of favorable bottom and shoreline features with appropriate salinity ranges (Browder 1991; Jassby et al 1995). Maintaining a healthy oligohaline zone will be an important step toward successful restoration and maintenance of the St. Lucie Estuary.

Table B-1. A Partial List of Fish and Shellfish Collected in Oligohaline Waters.

Scientific Name	Common Name	Size Class			Location	Reference
		Adult	Juvenile	Not Specified		
*Achirus lineatus**	Lined sole			✔	St. Louis Bay, MS	Hackney and de la Cruz 1981
Adinia xenica	Diamond killifish			✔	St. Louis Bay, MS	Hackney and de la Cruz 1981
*Albula vulpes**	Bonefish		✔		St. Lucie River, FL	Haunert and Startzman 1985
Alosa aestivalis	Blueback herring			✔	North Carolina	Rozas and Hackney 1984
Alosa alabamae	Alabama shad			✔	Lake Maurepas, LA	Hastings et al. 1987
Alosa chysochloris	Skipjack herring			✔	Lake Maurepas, LA	Hastings et al. 1987
Alosa pseudoharengus	Alewife		✔		Parker River estuary, MA	Hughes et al. 2000
Amia calva	Bowfin			✔	Lake Maurepas, LA	Hastings et al. 1987
Anguilla rostrata	American eel			✔	Lake Maurepas, LA; Parker River Estuary, MA	Hastings et al. 1987; Hughes et al. 2000
*Anchoa mitchilli**	Bay Anchovy	✔	✔		Not specified; St. Lucie River, FL; York River, VA; Barataria Basin, LA; St. Louis Bay, MS; North Carolina; Calcasieu Estuary, LA; Lake Maurepas, LA.; Old Fort Bayou, MS; Little Manatee River, FL	Gunter 1961; Gunter and Hall 1963; Markle 1976; Day et al. 1980, Hackney and de la Cruz 1981; Rozas and Hackney 1984; Felley 1987; Hastings et al. 1987; Peterson and Ross 1991; Edwards 1992
Apeltes quadracus	Four-spined stickleback			✔	Parker River Estuary, MA	Hughes et al. 2000
Aphredoderus sayanus	Pirate perch			✔	Lake Maurepas, LA	Hastings et al. 1987
Aplodinotus grunniens	Freshwater drum			✔	Lake Maurepas, LA	Hastings et al. 1987
*Archosargus probatocephalus**	Sheepshead			✔	Lake Maurepas, LA	Hastings et al. 1987
*Arius felis**	Hardhead catfish			✔	Lake Maurepas, LA; Little Manatee River, FL	Hastings et al. 1987; Edwards 1992
Astroscopus sp.	Stargazer			✔	North Carolina	Rozas and Hackney 1984
*Bagre marinus**	Gafftopsail catfish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Bairdiella chrysoura**	Silver perch			✔	York River, VA; North Carolina	Markle 1976; Rozas and Hackney 1984
Brevoortia patronus	Gulf menhaden		✔		Grand and White Lakes, LA; Calcasieu Estuary, LA; Lake Maurepas, LA; Old Fort Bayou, MS	Gunter 1961; Felley 1987; Hastings et al. 1987; Peterson and Ross 1991
*Brevoortia smithii**	Fine-scale menhaden		✔		St. Lucie River, FL	Gunter and Hall 1963
*Brevoortia tyrannus**	Atlantic menhaden		✔		North Carolina	Rozas and Hackney 1984
*Callenectes sapidus**	Blue crab	✔	✔		Grand and White Lakes, LA; Barataria Basin, LA; St. Louis Bay, MS	Gunter 1961; Day et al., 1980; Hackney and de la Cruz 1981
*Caranx hippos**	Crevalle jack			✔	Lake Maurepas, LA	Hastings et al. 1987
Carpoides carpio	River carpsucker			✔	Lake Maurepas, LA	Hastings et al. 1987
Catostomus commersoni	White sucker		✔		Parker River Estuary, MA	Hughes et al. 2000
*Centropomus undecimalis**	Snook		✔		St. Lucie River, FL; Indian River Lagoon, FL; Little Manatee River, FL	Gunter and Hall 1963; Haunert and Startzman 1980, 1985; Peterson and Gilmore 1991; Edwards 1992
*Citharichthys spilopterus**	Bay whiff			✔	Lake Maurepas, LA	Hastings et al. 1987
Crangon septemspinosa	Sand shrimp			✔	Parker River Estuary, MA	Hughes et al. 2000

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		Adult	Juvenile	Not Specified		
Cynoscion arenarius	Sand seatrout			✔	Lake Maurepas, LA	Hastings et al. 1987
*Cynoscion nebulosus**	Spotted seatrout		✔	✔	St. Louis Bay, MS; Little Manatee River, FL	Hackney and de la Cruz 1981; Edwards 1992
*Cynoscion regalis**	Weakfish			✔	York River, VA	Markle 1976
*Cyprinodon variegatus**	Sheepshead minnow			✔	Lake Maurepas, LA	Hastings et al. 1987
Cyprinus carpio	Common carp			✔	Lake Maurepas, LA	Hastings et al. 1987
*Dasyatis sabina**	Atlantic stingray			✔	Lake Maurepas, LA	Hastings et al. 1987
*Diapterus olisthostomus**	Sand perch			✔	St. Lucie River, FL	Gunter and Hall 1963
*Diapterus plumieri**	Striped moharra			✔	Little Manatee River, FL	Edwards 1992
Dormitator maculatus	Fat sleeper			✔	North Carolina	Rozas and Hackney 1984
*Dorosoma cepedianum**	Gizzard shad			✔	North Carolina; St. Lucie River, FL; Lake Maurepas, LA	Rozas and Hackney 1984; Haunert and Startzman 1985; Hastings et al. 1987
*Dorosoma petenense**	Threadfin shad			✔	Lake Maurepas, LA	Hastings et al. 1987
Elassoma zonatum	Banded pygmy sunfish			✔	Lake Maurepas, LA	Hastings et al. 1987
Eleotris pisonis	Spinycheek sleeper			✔	North Carolina	Rozas and Hackney 1984
*Elops saurus**	Ladyfish		✔	✔	James River, VA; St. Lucie River, FL; Lake Maurepas, LA	Govoni and Merriner 1978; Haunert and Startzman 1985; Hastings et al. 1987
*Enneacanthus gloriosus**	Bluespotted sunfish			✔	Atlantic coast	Rozas and Hackney 1983 citing Raney and Massmann 1953
Esox niger	Chain pickerel			✔	Parker River Estuary, MA	Hughes et al. 2000
Euciniostomus juveniles*	Moharra		✔		Little Manatee River, FL	Edwards 1992
*Eucinostomus argenteus**	Spotfin Mojarra			✔	St. Lucie River, FL	Gunter and Hall 1963
Eucinostomus lefroyi	Mottled moharra			✔	North Carolina	Rozas and Hackney 1984
*Evorthodus lyricus**	Lyre goby			✔	St. Louis Bay, MS; North Carolina	Hackney and de la Cruz 1981; Rozas and Hackney 1984
Fundulus chrysotus	Golden topminnow			✔	Gulf Coast; Lake Maurepas, LA	Hastings et al. 1987
*Fundulus confluentus**	Marsh killifish			✔	St. Louis Bay, MS	Hackney and de la Cruz 1981
Fundulus diaphanus	Banded killifish			✔	Parker River Estuary, MA	Hughes et al. 2000
*Fundulus grandis**	Gulf killifish			✔	St. Louis Bay, MS; Lake Maurepas, LA	Hackney and de la Cruz 1981; Hastings et al. 1987
Fundulus heteroclitus	Mummichog			✔	North Carolina; Plum Island Sound, MA; Parker River Estuary, MA.	Rozas and Hackney 1984; Deegan and Garritt 1997; Hughes et al. 2000
Fundulus jenkinsi	Saltmarsh topminnow			✔	Old Fort Bayou, MS	Peterson and Ross 1991
Fundulus luciae	Spotfin killifish			✔	North Carolina	Rozas and Hackney 1984
Fundulus pulvereus	Bayou killifish			✔	Lake Maurepas, LA; Old Fort Bayou, MS	Hastings et al. 1987; Peterson and Ross 1991
*Fundulus seminolis**	Seminole killifish			✔	Little Manatee River, FL	Edwards 1992
*Galeichthys felis**	Sea catfish	✔	✔		St. Lucie River, FL	Gunter and Hall 1963

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*Gambusia affinis**	Mosquito fish	✔	✔		St. Lucie River, FL; North Carolina; St. Lucie River, FL; Lake Maurepas, LA; Little Manatee River, Florida	Gunter and Hall 1963; Rozas and Hackney 1984; Haunert and Startzman 1985; Hastings et al. 1987; Edwards 1992
*Gobionellus boleosoma**	Darter goby			✔	St. Lucie River, FL	Gunter and Hall 1963
*Gobionellus hastatus**	Sharptail goby			✔	North Carolina	Rozas and Hackney 1984
Gobionellus shufeldti	Freshwater goby			✔	North Carolina; Lake Maurepas, LA	Rozas and Hackney 1984; Hastings et al. 1987
*Gombiosoma bosci**	Naked goby			✔	St. Louis Bay, MS; Lake Maurepas, LA	Hackney and de la Cruz 1981; Hastings et al. 1987
*Heterandria formosa**	Least killifish			✔	St. Lucie River, FL; Lake Maurepas, LA	Gunter and Hall 1963; Hastings et al. 1987
*Ictalurus catus**	White catfish	✔	✔		St. Lucie River, FL; York River, VA; North Carolina; St. Lucie River, FL	Gunter and Hall 1963; Markle 1976; Rozas and Hackney 1984; Haunert and Startzman 1985
Ictalurus furcatus	Blue catfish			✔	Lake Maurepas; LA	Hastings et al. 1987
Ictalurus melas	Black bullhead			✔	Lake Maurepas, LA	Hastings et al. 1987
Ictalurus natalis	Yellow bullhead			✔	Lake Maurepas, LA	Hastings et al. 1987
*Ictalurus nebulosus**	Brown bullhead			✔	St. Lucie River, FL	Gunter and Hall 1963
*Ictalurus punctatus**	Channel catfish			✔	York River, VA; Lake Maurepas, LA	Markle 1976; Hastings et al. 1987
Ictiobus bubalus	Smallmouth buffalo			✔	Lake Maurepas, LA	Hastings et al. 1987
Labidesthes sicculus	Brook silverside			✔	Lake Maurepas, LA	Hastings et al. 1987
*Lagondon rhomboides**	Pinfish			✔	North Carolina; Little Manatee River, FL	Rozas and Hackney 1984; Edwards 1992
*Leiostomus xanthurus**	Spot			✔	York River, VA; North Carolina; Lake Maurepas, LA; Little Manatee River, FL	Markle 1976; Rozas and Hackney 1984; Hastings et al. 1987; Edwards 1992
Lepisosteus oculatus	Spotted gar			✔	Lake Maurepas; LA	Hastings et al. 1987
Lepisosteus ossesus	Longnose gar			✔	North Carolina; Hastings et al. 1987	Rozas and Hackney 1984; Hastings et al. 1987
Lepisosteus spatula	Alligator Gar			✔	Lake Maurepas, LA	Hastings et al. 1987
Lepomis gibbosus	Pumpkinseed	✔	✔		North Carolina	Rozas and Hackney 1984
Lepomis gulosus	Warmouth			✔	Lake Maurepas, LA	Hastings et al. 1987
*Lepomis macrochirus**	Bluegill	✔	✔		St. Louis Bay, MS; Lake Maurepas, LA; Little Manatee River, FL; Plum Island Sound, MA.	Hackney and de la Cruz 1981; Hastings et al. 1987; Edwards 1992; Deegan and Garritt 1997
Lepomis meglotis	Longear sunfish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Lepomis microlophus**	Redear sunfish			✔	Lake Maurepas, LA	Hastings et al. 1987
Lepomis punctatus	Spotted sunfish			✔	Lake Maurepas, LA	Hastings et al. 1987
Lepomis symmetricus	Bantam sunfish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Lucania parva**	Rainwater killifish			✔	St. Louis Bay, MS; Lake Maurepas, LA; Little Manatee River, FL	Hackney and de la Cruz 1981; Hastings et al. 1987; Edwards 1992
*Lutjanus griseus**	Gray snapper			✔	St. Lucie River, FL	Gunter and Hall 1963
*Megalops atlanticus**	Tarpon		✔		St. Lucie River, FL	Haunert and Startzman 1985
*Membras martinica**	Rough silverside			✔	St. Louis Bay, MS	Hackney and de la Cruz 1981

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		Adult	Juvenile	Not Specified		
*Menidia beryllina**	Inland or tidewater silverside			✔	North Carolina; Calcasieu Estuary, LA; Lake Maurepas, LA; Old Fort Bayou, MS.; Little Manatee River, Florida	Rozas and Hackney 1984; Felley 1987; Hastings et al. 1987; Peterson and Ross 1991; Edwards 1992
*Menidia menidia**	Atlantic silverside			✔	Plum Island Sound, MA; Parker River Estuary, MA.	Deegan and Garritt 1997; Hughes et al. 2000
*Microgobius gulosus**	Clown goby			✔	Lake Maurepas, LA	Hastings et al. 1987
*Micropogon undulatus**	Atlantic croaker		✔	✔	Grand and While Lakes, LA; York River, VA; Upper Barataria Basin, LA; North Carolina; Lake Maurepas, LA	Gunter 1961; Markle 1976; Day et al. 1980; Rozas and Hackney 1984; Hastings et al. 1987
*Micropterus salmoides**	Largemouth bass	✔	✔		St. Louis Bay, MS; North Carolina; Lake Maurepas, LA	Hackney and de la Cruz 1981; Hackney and Rozas 1984; Hastings et al. 1987
Morone americana	White perch			✔	York River, VA; Plum Island Sound, MS	Markle 1976; Deegan and Garritt 1997
Morone chrysops	White bass			✔	Lake Maurepas, LA	Hastings et al. 1987
Morone mississippiensis	Yellow bass			✔	Lake Maurepas; LA	Hastings et al. 1987
Morone saxatilis	Striped bass	✔	✔	✔	York River, VA; North Carolina; Lake Maurepas, LA	Markle 1976; Rozas and Hackney 1984; Hastings et al. 1987
*Mugil cephalus**	Striped mullet*		✔	✔	St. Lucie River, FL; St. Louis Bay, MS; North Carolina; Lake Maurepas, LA; Little Manatee River, FL	Haunert and Starzman 1980; Hackney and de la Cruz 1981; Rozas and Hackney 1984; Hastings et al. 1987; Edwards 1992
*Mugil curema**	Silver mullet*		✔		St. Lucie River, FL	Gunter and Hall 1963
Myrophis punctatus	Speckled worm eel			✔	North Carolina; Lake Maurepas, LA	Rozas and Hackney 1984; Hastings et al. 1987
Notemigonus crysoleucas	Golden shiner			✔	St. Lucie River, FL	Hughes et al. 2000
*Notemigonus crysoleucas**	Golden shiner			✔	Lake Maurepas, LA	Hastings et al. 1987
Notropis emiliae	Pugnose minnow			✔	Lake Maurepas, LA	Hastings et al. 1987
Notropis petersonii	Coastal shiner			✔	Old Fort Bayou, MS	Peterson and Ross 1991
Noturus gyrinus	Tadpole madtom			✔	Lake Maurepas, LA	Hastings et al. 1987
*Oligoplites saurus**	Leatherjacket			✔	St. Louis Bay, MS	Hackney and de la Cruz 1981
Osmerus mordax	Rainbow smelt			✔	Parker River Estuary, MA	Hughes et al. 2000
Palaemonetes bulgaris	Grass shrimp			✔	Parker River Estuary, MA	Hughes et al. 2000
Palaemonetes pugio	Grass shrimp	✔	✔		St. Louis Bay, MS; North Carolina	Hackney and de la Cruz 1981; Rozas and Hackney 1984
Paralichthys lethostigma	Southern flounder		✔		North Carolina, Calcasieu Estuary, LA; Lake Maurepas, LA	Rozas and Hackney 1984; Felley 1987; Hastings et al. 1987
*Penaeus aztecus**	Brown shrimp		✔	✔	Grand and White Lakes, LA; St. Lucie River, FL; Old Fort Bayou, MS	Gunter 1961; Peterson and Ross 1991
Penaeus setiferus	White shrimp		✔	✔	Grand and White Lakes, LA;Calcasieu Estuary, LA; Old Fort Bayou, MS	Gunter 1961; Gunter and Hall 1963; Felley 1987; Peterson and Ross 1991
Petromyzon marinus	Sea lamprey			✔	Parker River Estuary, MA	Hughes et al. 2000
Pleuronectes americanus	Winter Flounder			✔	Plum Island Sound, MS	Deegan and Garritt 1997
*Poecilia latipinna**	Sailfin molley			✔	Little Manatee River, FL	Edwards 1992
*Pogonias cromis**	Black drum			✔	Lake Maurepas, LA	Hastings et al. 1987

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		Adult	Juvenile	Not Specified		
Polyodon spathula	Paddlefish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Pomatomus saltatrix**	Bluefish			✔	North Carolina; Plum Island Sound, MS	Rozas and Hackney 1984; Deegan and Garritt 1997
Pomoxis annularis	White crappie			✔	Lake Maurepas, LA	Hastings et al. 1987
*Pomoxis nigromacuatus**	Black crappie			✔	North Carolina; St. Lucie River, FL; Lake Maurepas, LA	Rozas and Hackney 1984; Haunert and Startzman 1985; Hastings et al. 1987
Pungitius pungitius	Nine-spined stickleback			✔	Parker River Estuary, MA	Hughes et al. 2000
Pylodictus olivaris	Flathead catfish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Sciaenops ocellatus**	Red drum		✔	✔	St. Lucie River, FL; Little Manatee River, FL	Haunert and Starzman 1980; Edwards 1992
*Strongylura marina**	Atlantic needlefish			✔	North Carolina; Lake Maurepas, LA	Rozas and Hackney 1984; Hastings et al. 1987
*Sygnathus scovelli**	Gulf pipefish			✔	Lake Maurepas, LA	Hastings et al. 1987
*Symphurus plagiusa**	Blackcheek tonguefish			✔	Gulf and Atlantic Coasts	Rozas and Hackney 1983 citing Rounsefell 1964
Syngnathus fuscus	Northern pipefish			✔	Parker River Estuary, MA	Hughes et al. 2000
*Syngnathus louisianae**	Chain pipefish			✔	Gulf Coast	Rozas and Hackney 1983 citing Dahlberg 1972
*Synodus foetens**	Inshore lizardfish			✔	Gulf Coast	Rozas and Hackney 1983 citing Dahlberg 1972
*Trinectes maculatus**	Hogchoker			✔	Grand and White Lakes, LA; York River, VA; Lake Maurepas, LA; Little Manatee River, FL	Gunter 1961; Markle 1976; Hastings et al. 1987; Edwards 1992

* Species found in the St. Lucie Estuary (included in species lists in Gunter and Hall 1963 and/or Haunert and Startzman 1980, 1985).

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